IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of	:	**Confirmation No. 8254**
Koji OIKE et al.	:	Attorney Docket No. 2005_0362A
Serial No. 10/528,586	:	Group Art Unit 2855
Filed March 21, 2005	:	Examiner Octavia L. Davis
DETECTOR OF ABSOLUTE ROTATION ANGLE AND TORQUE	:	**Mail Stop: Amendment**

SUBMISSION OF VERIFIED
ENGLISH TRANSLATION OF PRIORITY DOCUMENT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Enclosed herewith is a verified English translation of the priority document (JP 2003-309794) for the present application, thereby perfecting the priority date of September 2, 2003.

Respectfully submitted,

Koji OIKE et al.

By: Kenneth W. Fields
Kenneth W. Fields
Registration No. 52,430
Attorney for Applicants

KWF/jjv
Washington, D.C. 20006-1021
Telephone (202) 721-8200
Facsimile (202) 721-8250
May 16, 2007

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2005_0362A/KWF/00169

OIPE IAP97
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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Koji OIKE et al. : Art Unit:
Serial No.: 10/528,586 : Examiner:
Filed: March 21, 2005
FOR: Detector of Absolute Rotation Angle and Torque

VERIFICATION OF A TRANSLATION

Assistant Commissioner for Patents
Washington, D.C. 20231
SIR :

I, the below named translator, hereby declare that:

1. My name and post office address are as stated below.

2. That I am knowledgeable in the English language and in the language of JP2003-309794, and I believe the attached English translation to be a true and complete translation of JP2003-309794.

3. The document for which the attached English translation is being submitted is a patent application on an invention entitled Detector of Absolute Rotation Angle and Torque.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and

belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Date: April 17, 2007

Katsuki Hirano
Full name of the Translator

K. Hirano
Signature of the Translator

c/o Matsushita Technical Information Services Co., Ltd.,
Osaka Business Park, Matsushita IMP Bldg., 18th Floor,
1-3-7, Shiromi, Chuo-ku, Osaka-shi, Osaka, 540-6318 Japan

Post Office Address

(19) Japanese patent Office

(12) Patent Publication (A)

(11) Japanese Patent No. 2005-77304

(51) Int. Cl.	Fl.
G01L 3/10	G01L 3/10
B62D 5/04	G01L 3/10
B62D 5/06	B62D 5/04
G01D 5/245	B62D 5/06
G01B 7/30	G01D 5/245
	G01B 7/30

(21) Application Number: P2003-309794

(22) Data of Filing: 2003.9.2

(71) Applicant: Matsushita Electric Industrial Co., Ltd.

1006, Oaza-Kadoma, Kadoma-shi, Osaka

(74) AGENT 100097445

Fumio IWAHASHI, Patent Attorney

(74) AGENT 100103355

Tomoyasu SAKAGUCHI, Patent Attorney

(74) AGENT 100109667

Hiroki NAITO, Patent Attorney

(72) Inventor Koji OIKE

1006, Oaza-Kadoma, Kadoma-shi, Osaka

Matsushita Electronic Components Co., Ltd.

(72) Inventor Kiyotake UEHIRA
1006, Oaza-Kadoma, Kadoma-shi, Osaka
Matsushita Electronic Components Co., Ltd.
(72) Inventor Masaharu USHIHARA
1006, Oaza-Kadoma, Kadoma-shi, Osaka
Matsushita Electronic Components Co., Ltd.

(54) [Title of the Invention] Detector of Absolute Rotation Angle and Torque

(57) [Abstract]

[Object] Provide a detector of absolute rotation angle and torque, used for power steering of a motor vehicle, etc. and capable of high-density and high-resolution detection of torque and of absolute rotation angle with a simple construction.

[Mean to Solve the Problems] This detector is composed of a first absolute rotation angle detecting unit comprising:

a first gear 1 coupled to an input shaft 2, and a gear A6 turning in engagement with this first gear 1, and disposed at the center of this gear A6; and

a second absolute rotation angle detecting unit comprising:

a second gear 3 coupled to an output shaft 4, and a gear B7 turning in engagement with this second gear 3, and disposed at the center of this gear B7.

[Selected drawing] Fig. 1

[What is claimed is]

[Claim 1] A detector of absolute rotation angle and torque composed of a first absolute rotation angle detecting unit comprising:

a first gear coupled to an input shaft, and a gear A turning in engagement with this first gear; and

a second absolute rotation angle detecting unit comprising:

a second gear coupled to an output shaft, and a gear B turning in engagement with this second gear, and disposed at the center of this gear B.

[Claim 2] A detector of absolute rotation angle and torque as defined in Claim 1, wherein the first and second absolute rotation angle detecting units are composed, respectively, of a first and a second magnets and a first and a second magnetic detecting elements disposed at positions facing those magnets.

[Claim 3] A detector of absolute rotation angle and torque as defined in Claim 1, wherein a torsion bar is provided between the input shaft and the output shaft.

[Claim 4] A detector of absolute rotation angle and torque as defined in Claim 1, wherein the first and the second gears have one same number of teeth and the gear A has a number of teeth different from that of the gear B;

the absolute rotation angle is calculated from the difference in absolute rotation angle between said gear A and said gear B; and

the torque is calculated with a differential from the difference between the absolute rotation angle of said gear A and the absolute rotation angle of said gear B, multiplied by the gear ratio of said gear A to gear B.

[Claim 5] A detector of absolute rotation angle and torque as defined in Claim 1, wherein the first gear has a number of teeth different from that of the second gear, and the gear A and the gear B have one same number of teeth;

the absolute rotation angle is calculated from the difference in absolute rotation angle between said gear A and said gear B; and

the torque is calculated with a differential from the difference between the absolute rotation angle of said gear A and the absolute rotation

angle of said gear B, multiplied by the gear ratio of said gear A to gear B.

[Claim 6] A detector of absolute rotation angle and torque as defined in Claim 4 or 5, wherein the absolute rotation angle of the gear A and the gear B is stored in a nonvolatile memory respectively, and the absolute rotation angle and the torque are determined based on the absolute rotation angles of said gear A and said gear B calculated from the rotation angle from said absolute rotation angle in initial period.

[Claim 7] A detector of absolute rotation angle and torque as defined in Claim 4 or 5, wherein a correction angle which is the difference between ideal value and real value of the absolute rotation angle of the gear A and the gear B is stored in a nonvolatile memory respectively over the rotation angle detecting range, and the absolute rotation angle and the torque are determined based on the absolute rotation angles of said gear A and said gear B modified by said correction angle.

[Claim 8] A detector of absolute rotation angle and torque as defined in Claim 4, wherein an abnormality is announced, in case the difference between the absolute rotation angle of the gear A and the absolute rotation angle of the gear B, multiplied by the gear ratio of said gear A to said gear B has become no smaller than a prescribed value.

[Claim 9] A detector of absolute rotation angle and torque as defined in Claim 5, wherein an abnormality is announced, in case the difference between the absolute rotation angle of the gear A and the absolute rotation angle of the gear B, multiplied by the gear ratio of the first and second gears has become no smaller than a prescribed value.

[Detailed Description of the Invention]

[Technical Field]

[0001]

The present invention concerns a detector of absolute rotation angle and torque used in power steering of a vehicle, etc., more specifically a torque detector capable of detecting an absolute rotation angle of steering and a torque simultaneously.

[Background Art]

[0002]

Conventionally, a system as shown in Fig. 7 is known as a system for detecting a torque and an absolute rotation angle. In Fig. 7, a gear unit 18 is mounted fixedly, through an engaging spring 19, to a shaft (not illustrated) the rotation angle of which is to be detected. The gear unit 18 is engaged with a gear unit 21 on which is mounted a code plate 20 polarized with a plurality of magnetic poles at the end face of its outer circumference, and the magnetic poles provided on the code plate 20 move with a rotation of the shaft to be detected. The detector detects the rotation angle by counting the number of those magnetic poles by means of a detecting element 22 provided facing the end face of the outer circumference. Moreover, by mounting the mechanism by this construction to two shafts coupled through a torsion bar respectively, it is also possible to detect the amount of the torque which acted, by comparing the rotation angle of the respective shafts, in case of occurrence of any torsion between the shafts as a result of working of torque between the two shafts.

[0003]

As documentary information of prior art relating to the invention of

the present application is known patent literature 1, for example.

Patent literature 1: Japanese Laid-Open Patent Publication No. H11-194007.

[Disclosure of the Invention]

[Problems to be Solved by the Invention]

[0004]

However, in a rotation angle sensor or a torque detecting sensor constructed as above, which detects the rotation angle of the shafts by counting the number of movements of a plurality of magnetic poles disposed on the end face at the outer circumference of the code plate 20, it is necessary to reduce the dimension of the polarized magnetic poles for improving the resolution of the detected angle, and this presented problems such as difficulty of obtaining a strong magnetic field and necessity of polarizing a plurality of magnetic poles with good accuracy for improving the detecting accuracy. Furthermore, another problem was that this rotation angle sensor detects relative rotation angle only, and cannot detect any absolute rotation angle.

[0005]

The objective of the present invention, realized for solving the above-mentioned problems, is to provide a detector of absolute rotation angle and torque for perfoming high-accuracy and high-resolution detection of torque and absolute rotation angle with a simple construction using a single-pole magnet.

[Means for Solving the Problems]

[0006]

To achieve the above-described objective, the present invention has the following construction:

[0007]

The invention described in Claim 1 of the present invention is constructed with a first absolute rotation angle detecting unit comprising a first gear coupled to an input shaft, and a gear A turning in engagement with this first gear, and a second absolute rotation angle detecting unit comprising a second gear coupled to an output shaft, and a gear B turning in engagement with this second gear, and disposed at the center of this gear B. It provides an advantage of enabling to perfom high-accuracy and high-resolution detection of torque and absolute rotation angle with a simple construction.

[0008]

The invention described in Claim 2 of the present invention is a detector of absolute rotation angle and torque, wherein, especially, the first and second absolute rotation angle detecting units are constructed, respectively, with a first and a second magnets and a first and a second magnetic detecting elements disposed at positions facing those magnets. It provides an advantage of enabling to improve durability and reliability of the apparatus, thanks to the possibility of detecting an absolute rotation angle of the gear A and the gear B by a non-contact method.

[0009]

The invention described in Claim 3 of the present invention is a detector of absolute rotation angle and torque of a construction in which, especially, a torsion bar is provided between the input shaft and the output

shaft, and it provides an advantage of enabling to enhance the resolution in the detection of torque, thanks to the possibility of expanding the torsional angle corresponding to the torque.

[0010]

The invention described in Claim 4 of the present invention is a detector of absolute rotation angle and torque in which, especially, the first and the second gears have one same number of teeth and the gear A has a number of teeth different from that of the gear B, the absolute rotation angle is calculated from the difference in absolute rotation angle between the gear A and the gear B, and the torque is calculated with a differential from the difference between the absolute rotation angle of the gear A and the absolute rotation angle of the gear B, multiplied by the gear ratio of gear A to gear B. It provides an advantage of enabling to perfom high-accuracy and high-resolution detection of torque and absolute rotation angle with a simple construction.

[0011]

The invention described in Claim 5 of the present invention is a detector of absolute rotation angle and torque in which, especially, the first gear has a number of teeth different from that of the second gear, and the gear A and the gear B have one same number of teeth, the absolute rotation angle is calculated from the difference in absolute rotation angle between the gear A and the gear B, and the torque is calculated with a differential from the difference between the absolute rotation angle of the gear A and the absolute rotation angle of the gear B, multiplied by the gear ratio of gear A to gear B. It provides an advantage of enabling to perfom high-accuracy and

high-resolution detection of torque and absolute rotation angle with a simple construction.

[0012]

The invention described in Claim 6 of the present invention is a detector of absolute rotation angle and torque in which, especially, the absolute rotation angle of the gear A and the gear B is stored in a nonvolatile memory respectively, and the absolute rotation angle and the torque are determined based on the absolute rotation angles of the gear A and the gear B calculated from the rotation angle from this initial absolute rotation angle. It provides an advantage of not requiring to mechanically fit the initial absolute rotation angle of the gear A and the gear B to each other.

[0013]

The invention described in Claim 7 of the present invention is a detector of absolute rotation angle and torque in which, especially, a correction angle which is the difference between ideal value and real value of the absolute rotation angle of the gear A and the gear B is stored in a nonvolatile memory respectively over the rotation angle detecting range, and the absolute rotation angle and the torque are determined based on the absolute rotation angles of the gear A and said gear B modified by this correction angle. It provides an advantage of enabling to detect absolute rotation angle and torque with higher accuracy.

[0014]

The invention described in Claim 8 of the present invention is a detector of absolute rotation angle and torque in which, especially, an abnormality is announced, in case the difference between the absolute

rotation angle of the gear A and the absolute rotation angle of the gear B, multiplied by the gear ratio of gear A to gear B has become no smaller than a prescribed value. It provides an advantage of not outputting to outside the apparatus any value of absolute rotation angle and/or torque which became unusual because of a trouble with the mechanism, the circuit, elements, etc. of this apparatus.

[0015]

The invention described in Claim 9 of the present invention is a detector of absolute rotation angle and torque in which, especially, an abnormality is announced, in case the difference between the absolute rotation angle of the gear A and the absolute rotation angle of the gear B, multiplied by the gear ratio of first gear to second gear has become no smaller than a prescribed value. It provides an advantage of not outputting to outside the apparatus any value of absolute rotation angle and/or torque which became unusual because of a trouble with the mechanism, the circuit, elements, etc. of this apparatus.

[Advantages of the Invention]

[0016]

The present invention provides a detector of absolute rotation angle and torque constructed with a first absolute rotation angle detecting unit comprising a first gear coupled to an input shaft, and a gear A turning in engagement with this first gear, and a second absolute rotation angle detecting unit comprising a second gear coupled to an output shaft, and a gear B turning in engagement with this second gear, and disposed at the center of this gear 8. It provides an advantage of enabling to perfom

high-accuracy and high-resolution detection of torque and absolute rotation angle with a simple construction described above.

[Preferred Embodiment of the Invention]

[0017]

Fig. 1 is a basic construction diagram of the detector of absolute rotation angle and torque in a preferred embodiment of the present invention.

Fig. 2 is a principle diagram for determining an absolute rotation angle.

Fig. 3 is a principle diagram for determining a torque.

Fig. 4 is a diagram showing the relationship between the absolute rotation angle of the first and second gears and the absolute rotation angle of the gears A, B.

Fig. 5 is a circuit block chart of the detector of absolute rotation angle and torque.

Fig. 6 is a diagram showing an ideal value and a real value of absolute rotation angle of the gears A and B.

[0018]

In Fig. 1, the first gear 1 is coupled to the input shaft 2 and, similarly, the second gear 3 is fit and coupled to the output 4. The torsion bar 5 is disposed concentrically between the input shaft 2 and the output 4. The gear A6 is coupled to the first gear 1 and, similarly, the gear B7 is fit and coupled to the second gear 3, and at their center are installed a first magnet 8 and a second magnet 9. At the position opposite to the first magnet 8 is disposed a first magnetic detecting element 10 for detecting this direction of

magnetic field, and at the position opposite to the second magnet 9 is disposed a second magnetic detecting element 11 for detecting this direction of magnetic field, through substrates 12, 13 respectively. The first absolute rotation angle detecting unit is constituted with those first magnet 8 and first magnetic detecting element 10, while the second absolute rotation angle detecting unit is constituted with the second magnet 9 and the second magnetic detecting element 11. Here, the first gear 1 and the second gear 3 have one same number of teeth, which is given as "c." On the other hand, the gear A6 will have a number of teeth "a" and the gear B will have a number of teeth "b", "a" and "b" being in the relation of a $\neq$ b.

[0019]

In the diagram in the upper stage of Fig. 2, the axis of abscissa indicates the absolute rotation angles of the first gear 1 and the second gear 3, while the axis of ordinate indicates the absolute rotation angles of the gear A6 and the gear B7. "x" indicates the absolute rotation angle of the gear A6, while "y" indicates the absolute rotation angle of the gear B7.

[0020]

In the diagram in the lower stage of Fig. 2, the axis of abscissa indicates the absolute rotation angles of the first gear 1 and the second gear 3, while the axis of ordinate indicates the difference in absolute rotation angle (x - y) between the gear A6 and the gear B7.

[0021]

In Fig. 3, the axis of abscissa indicates the absolute rotation angles of the first gear 1 and the second gear 3, while the axis of ordinate indicates the difference between the absolute rotation angle of the gear A6 and the

absolute rotation angle of the gear B7, multiplied by the gear ratio of gear A6 to gear B7.

[0022]

In Fig. 4, the axis of abscissa indicates the absolute rotation angles of the first gear 1 and the second gear 3, while the axis of ordinate indicates the absolute rotation angle of the gear A6 and gear B7.

[0023]

In Fig. 5, the first magnetic detecting element 10 and the second magnetic detecting element 11 installed on the substrate 12 and the substrate 13 of the detector of absolute rotation angle and torque are connected to a CPU 14. To this CPU 14 is also coupled EEPROM 15 which is a nonvolatile memory. On the other hand, this CPU 14 is further coupled to a master CPU 17 through a serial communication line 16, for outputting the absolute rotation angle and torque calculated in the CPU 14.

[0024]

In the diagram in the upper stage of Fig. 6, the axis of abscissa indicates the absolute rotation angles of the first gear 1 and the second gear 3, while the axis of ordinate indicates the absolute rotation angles of the gear A6 and the gear B7. Here, the dotted line indicates an ideal value of absolute rotation angle of the gear A6 and the gear B7, while the solid line indicates the real value of absolute rotation angle of the gear A6 and the gear B7.

[0025]

In the diagram in the lower stage of Fig. 6, the axis of abscissa indicates the absolute rotation angles of the first gear 1 and the second gear

3, while the axis of ordinate indicates the difference in absolute rotation angle (x - y) between the gear A6 and the gear B7. Here, the dotted line indicates an ideal value of this difference in absolute rotation angle (x - y), while the solid line indicates the real value thereof.

[0026]

Next, explanation will be given on how to calculate the absolute rotation angle of the first gear 1 and the second gear 3 as well as the torque imposed on the torsion bar 5.

[0027]

In Fig. 1, when the input shaft 2, the torsion bar 5 and the output shaft 4, which are made of one same rigid body, turn, the first gear 1 fit and coupled to this input shaft 2 turns. If this first gear 1 turns, the gear A6 which is engaged with this first gear 1 turns. Since the absolute rotation angle of this gear A6 agrees with the direction of magnetic field of the first magnet 8 disposed at the center, this direction of magnetic field is detected with the first magnetic detecting element 10 for calculation. On the other hand, the second gear 3 which is fit and coupled to the output shaft 4 also turns. If this second gear 3 turns, the gear B7 which is engaged with this second gear 3 turns. Since the absolute rotation angle of this gear B7 agrees with the direction of magnetic field of the first magnet 9 disposed at the center, this direction of magnetic field is detected with the second magnetic detecting element 11 for calculation. At that time, because the number of teeth "a" of the gear A6 is different from the number of teeth "b" of the gear B7, although the first gear 1 and the second gear 3 have one same number of teeth "c," the gear A6 and the gear B7 turn at speeds different

from each other against the input shaft 2, the torsion bar 5 and the output shaft 4.

[0028]

Explanation will be given on how to calculate the absolute rotation angle of the input shaft 2, the torsion bar 5 and the output shaft 4, which are made of one same rigid body, in Fig. 2.

[0029]

In the diagram in the upper stage of Fig. 2, the gear A6 turns at a speed equal to the rotational speed of the first gear 1 multiplied by the gear ratio (c/a), while the gear B7 turns at a speed equal to the rotational speed of the second gear 3 multiplied by the gear ratio (c/b). In the diagram in the lower stage of Fig. 2, because the number of teeth "a" of the gear A6 is different from the number of teeth "b" of the gear B7, the difference in absolute rotation angle (x - y) between the gear A6 and the gear B7 fluctuates with a certain regularity. Namely, it shows that, against the absolute rotation angle "z" of the first gear 1 and the second gear 3, the difference in absolute rotation angle (x - y) between the gear A6 and the gear B7 rides on a straight line in the absolute rotation angle detecting range, and that the absolute rotation angle "z" is determined uniformly against the absolute rotation angle (x - y).

[0030]

Explanation will be given on how to calculate the torsional angle corresponding to the torque imposed on the torsion bar 5, in Fig. 3. The axis of ordinate indicates the difference (hereinafter called T) between the absolute rotation angle of the gear A6 and the absolute rotation angle of the

gear B7, multiplied by the gear ratio (b/a) of gear A6 to gear B7. However, in case the value T of this difference became a negative value, it will be corrected with an addition of 180 deg. When no torque is imposed on the torsion bar 5 as shown in Fig. 3 (i.e. when no twist is produced on the torsion bar 5), the value T of this difference changes, ideally, in steps against the absolute rotation angle of the first gear 1 and the second gear 3. When a torque is imposed on the torsion bar 5, a difference is produced between the absolute rotation angle of the first gear 1 and the absolute rotation angle of the second gear 3, for an amount corresponding to the torsional angle (hereinafter called "ΔT").

[0031]

Suppose the output shaft 4 is fixed and the input shaft 2 turned by ΔT with twisting, the absolute rotation angle of the second gear 3 does not change, but the absolute rotation angle of the first gear 1 increases by ΔT in the direction of twisting. To turn this ΔT into an absolute rotation angle of the gear A6, it can be expressed as ΔT*(c/a). Namely, when a torque is imposed, this absolute rotation angle increases by ΔT*(c/a) against the ideal value T in Fig. 3. The ideal value T changes in steps in correspondence to the absolute rotation angles of the first gear 1 and the second gear 3 and, if the difference between adjacent ideal values (T1 and T2 for example) is of a value no less than twice the torsional angle at the maximum torque (hereinafter called "ΔTmax"), distinction can be made from the ideal value T. As a result, it becomes possible to calculate the value of ΔT*(c/a) corresponding to the torque. By adding this ΔT*(c/a) to the difference in absolute rotation angle (x - y) between the gear A6 and the gear B7 indicated

in Fig. 2, it also becomes possible to improve the detecting accuracy of the absolute rotation angle "z" of the first gear 1 and the second gear 3.

[0032]

On the other hand, in case any value no smaller than the torsional angle at maximum torque (ΔTmax) {ΔTmax*(c/a)} has been detected, it can be judged as showing occurrence of an abnormality somewhere in the mechanism, the circuit or the magnetic detecting element. In such a case, presence of of an abnormality can be informed to the master CPU17 from the serial communication line 16 indicated in Fig. 5.

[0033]

The detection of absolute rotation angle and the detection of torque described above are possible, even in the case where the gear A6 and the gear B7 in Fig. 1 have one same number of teeth and the number of teeth of the first gear 1 is different from that of the second gear 3.

[0034]

Next, explanation will be given on the method of aligning the zero points of absolute rotation angle of the gear A6 and the gear B7 by using Fig. 4, Fig. 5. Usually, the zero points of absolute rotation angle of the gear A6 and the gear B7 are not aligned, as shown in Fig. 4. The detecting method of absolute rotation angle and torque explained in Fig. 2, Fig. 3 is unworkable unless those zero points are aligned. It is therefore necessary to align the direction of the gear A6 and the gear B7 respectively at the time of their incorporation, but this is rather difficult because it requires a fairly high accuracy from the mechanical viewpoint. For that reason, it is so arranged as to enable, after all the gears have been incorporated, to transmit

a code for storing the initial absolute rotation angle of the gear A6 (calculated from the signal of the first magnetic detecting element 10) and the initial absolute rotation angle of the gear B7 (calculated from the signal of the second magnetic detecting element 11) in a nonvolatile memory (EEPROM 15) from the master CPU 17 to the CPU 14 through the serial communication line 16 indicated in Fig. 5. If the absolute rotation angles of the gear A6 and the gear B7 are determined from the rotational angle from those initial absolute rotation angles, those initial absolute rotation angles become the zero point. By reading in, each time when power is turned on, the initial absolute rotation angle stored in EEPROM 15 and taking the above-described measures, it becomes unnecessary to care about the direction of incorporation of the gear A6 and the gear B7.

[0035]

Explanation will be given on the method of improving the calculation accuracy of absolute rotation angle of the input shaft 2, the torsion bar 5 and the output 4 which are made of one same rigid body in Fig. 6.

[0036]

In the diagram in the upper stage of Fig. 6, the gear A6 turns at a speed equal to the rotational speed of the first gear 1 multiplied by the gear ratio (c/a), while the gear B7 turns at a speed equal to the rotational speed of the second gear 3 multiplied by the gear ratio (c/b).

[0037]

However, because of error in gear pitch, detecting error of absolute rotation angle, circuit error, etc. of the magnetic detecting element, the real values (value indicated with solid line) of absolute rotation angle of the gear

A6 and the gear B7 contain an error against the ideal values (value indicated with dotted line). As a result, the real value (value indicated with solid line) of the difference in absolute rotation angle (x - y) between the gear A6 and the gear B7 also fluctuates in a form containing an error against the ideal value (value indicated with dotted line), as shown in the diagram in the lower stage of Fig. 6.

[0038]

For that reason, the input shaft 2, the torsion bar 5 and the output 4, which are made of one same rigid body, indicated in Fig. 2 are turned with high accuracy by means of a motor, etc., before their loading on the vehicle. For this motor rotation (i.e. rotation of the first gear 1 and the second gear 3), a correction angle which is the difference between ideal value and real value of absolute rotation angle of the gear A6 and the gear B7 is stored respectively in EEPROM 15 indicated in Fig. 5. During a normal operation, the real value can be brought closer to the ideal value, by reading in the correction angle (stored in EEPROM 15) against the absolute rotation angle (real value) of the gear A6 and the gear B7, and adding that value to the real value.

[0039]

As described so far, the detector of absolute rotation angle and torque in a preferred embodiment of the present invention is constructed with a first absolute rotation angle detecting unit comprising a first gear coupled to an input shaft, and a gear A turning in engagement with this first gear, and a second absolute rotation angle detecting unit comprising a second gear coupled to an output shaft, and a gear B turning in engagement with this

second gear, and disposed at the center of this gear B. It provides an advantage of enabling to perfom high-accuracy and high-resolution detection of torque and absolute rotation angle with a simple construction described above.

[Industrial Applicability]

[0040]

The detector of absolute rotation angle and torque of the present invention provides an advantage of enabling to perfom high-accuracy and high-resolution detection of torque and absolute rotation angle with a simple construction, and is fit for use in the power steering of a vehicle, etc.

[Brief Description of the Drawing]

[0041]

Fig. 1 is a basic construction diagram of the detector of absolute rotation angle and torque in a preferred embodiment of the present invention.

Fig. 2 is a principle diagram for determining an absolute rotation angle in a preferred embodiment of the present invention.

Fig. 3 is a principle diagram for determining a torque in a preferred embodiment of the present invention.

Fig. 4 is a diagram showing the relationship between the absolute rotation angle of the first and second gears and the absolute rotation angle of the gears A, B in a preferred embodiment of the present invention.

Fig. 5 is a circuit block chart of the detector of absolute rotation angle and torque in a preferred embodiment of the present invention.

Fig. 6 is a diagram showing an ideal value and a real value of

absolute rotation angle of the gears A and B in a preferred embodiment of the present invention.

Fig. 7 is a sectional viewing showing the conventional system for detecting absolute rotation angle and torque.

[Description of the Reference Numerals and Signs]

[0042]

1: First gear

2: Input shaft

3: Second gear

4: Output shaft

5: Torsion bar

6: Gear A

7: Gear B

8: First magnet

9: Second magnet

10: First magnetic detecting element

11: Second magnetic detecting element

12: Substrate

13: Substrate

14: CPU

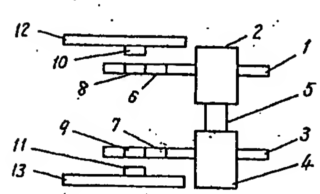
15: EEPROM

16: Serial communication line

17: Master CPU

[Fig. 1]

1: First gear
2: Input shaft
3: Second gear
4: Output shaft
5: Torsion bar
6: Gear A
7: Gear B
8: First magnet
9: Second magnet
10: First magnetic detecting element
11: Second magnetic detecting element
12, 13: Substrate

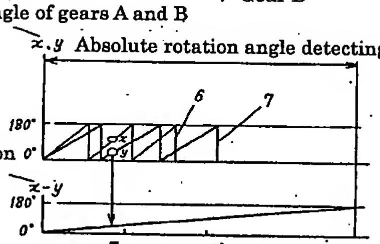


[Fig. 2]

6: Gear A

7: Gear B

Absolute rotation angle of gears A and B

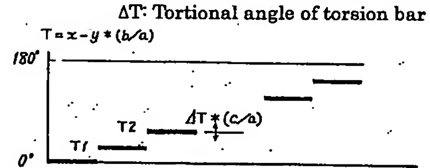


Difference in absolute rotation angle between gears A and B

Absolute rotation angle of first gear 1 and second gear 3

[Fig. 3]

a: Number of teeth of gear A
b: Number of teeth of gear B
c: Number of teeth of first gear 1 and second gear 3
ΔT: Tortional angle of torsion bar 5



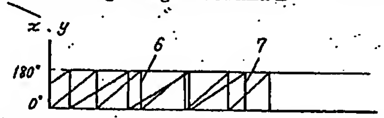
Absolute rotation angle of first gear 1 and second gear 3

[Fig. 4]

6: Gear A

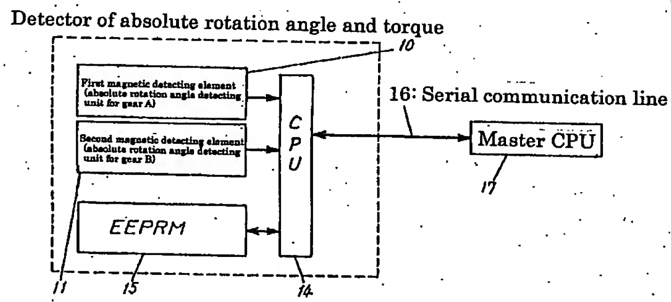
7: Gear B

Absolute rotation angle of gears A and B

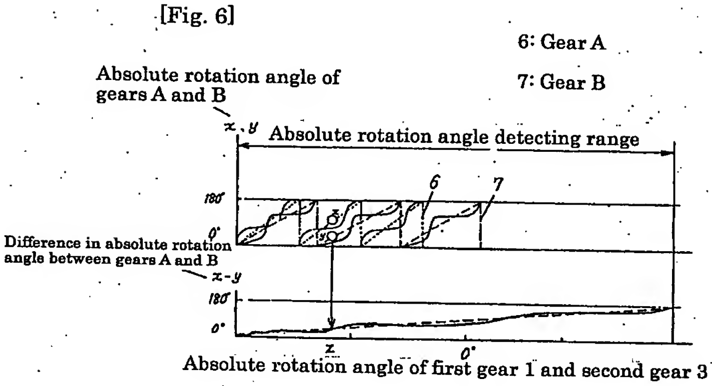


Absolute rotation angle of first gear 1 and second gear 3

[Fig. 5]



[Fig. 6]



[Fig.7]